Claims

1. A method of maintaining distributed time in a network having a plurality of timekeeping devices including a primary timekeeping entity, each said timekeeping device comprising a network node, the method comprising the steps of:

entering the time using an input mechanism on a first timekeeping device;

sending the time from said first timekeeping device to said primary timekeeping entity;

broadcasting a time update from said primary timekeeping entity to all other timekeeping entities, said broadcast repeating every T1 seconds and carrying an indication of the current time;

receiving said time update at a second timekeeping entity and starting a counting device upon said receipt;

checking the status of the counting device every T2 seconds and determining the elapsed time since said second timekeeping device received said time update.

comparing said elapsed time to a predetermined threshold value T3; and

if said elapsed time is greater than T3, making an indication that said second timekeeping device's time is unreliable.

2. The method of claim 1 wherein T2 is greater than T1.

3. The method of claim 1 wherein T2 is less than T1.

4. The method of claim 1 wherein said first device and said second device are the same.

5. The method of claim 1 wherein each of said plurality of timekeeping devices restarts said counting device upon the receipt of a time update.

6. The method of claim 1 wherein said primary timekeeping device is a network switch or router.

7. The method of claim 1 wherein said primary timekeeping device is a Fibre Channel switch.

8. The method of claim 1 wherein said plurality of timekeeping devices are Fibre Channel switches.

9. A computer readable media encoded with program instructions for causing one or more of said timekeeping devices to perform the method of claim 1.

10. A network switch for maintaining distributed time in a network having a plurality of timekeeping devices, said network switch comprising:

an I/O mechanism for receiving a time update from an operator;

a first port for sending said time update across said network to a primary timekeeping entity;

a second port for receiving a broadcast time update from said primary timekeeping entity every T1 seconds, said time update carrying an indication of the current time;

a counter for timing the age of the most recently received time update, said counter restarting upon receipt of said time update;

a microprocessor to (i) cause a status check upon said counter every T2 seconds, (ii) cause a determination of the elapsed time since said second timekeeping device received said time update, (iii) cause a comparison between said elapsed time and a predetermined threshold value T3; and (iv) cause an indication that said network switch is unsynchronized if said elapsed time is greater than T3.

11. The invention of claim 10 wherein T2 is greater than T1.

12. The invention of claim 10 wherein T2 is less than T1.

13. The invention of claim 10 wherein said first port and said second port are the same.

14. The invention of claim 10 wherein said primary timekeeping device is a network switch or router.

15. The invention of claim 10 wherein said primary timekeeping device is a Fibre Channel switch.

16. The invention of claim 10 wherein said network switch is a Fibre Channel switch.

17. A computer readable media encoded with program instructions for causing said network switch to perform the method of claim 10.

18. A method of securely distributing time updates in a network having a primary timekeeping entity and one or more other time keeping devices, the method comprising the steps of:

checking all timekeeping devices to determine if each is capable of participating in a secure time distribution system;

at the primary timekeeping entity, ascertaining the time and constructing a time update item;

creating a first-type derivative of said time update item;

creating a time update message comprising said time update item and said first-type derivative of said time update item;

sending the time update message to all timekeeping devices;

at a first timekeeping device receiving said time update message, processing said time update message, wherein processing said time update message includes the sub-steps of, (i) noting a time of arrival and storing said time of arrival in a first memory; (ii) starting a counter to measure the age of the received time update at a time interval Tmeasure; (iii) storing in a second memory, the time from said time update message; (iv) creating a second-type derivative of said update item; and (v) comparing said created second-type derivative of said update item with the received first-type derivative of said update item.

19. The method of claim 18 wherein processing said time update message comprises the additional sub-step of performing a frame delay check.

20. The method of claim 19 wherein the sub-step of performing a frame delay check comprises the steps of:

determining a difference between said time of arrival and said time from said time update message; and

comparing said difference with an information transfer delay threshold, said threshold representing the maximum tolerable latency for the transport of the time update message from the primary timekeeping entity to said first timekeeping device.

21. The method of claim 18 wherein said first memory and said second memory are the same.

22. The method of claim 18 wherein any device not capable of participating in said secure time distribution system is excluded from network.

23. The method of claim 18 wherein if any device is not capable of participating in said secure time distribution system, negating the availability of a secure mode in said network.

24. The method of claim 18 wherein the step of checking all timekeeping devices to determine if each is capable of participating in a secure time distribution system, comprises the sub-step of determining, for each checked timekeeping device, a software version or a hardware version.

25. The method of claim 18 wherein said first-type derivative and said second-type derivative comprise the same derivation process.

26. The method of claim 18 wherein creating a first-type derivative comprises the step to applying a hash function to achieve a first hashed result.

27. The method of claim 26 wherein creating a first-type derivative further involves the step of encrypting said first hashed result.

28. The method of claim 18 wherein the sub-step of comparing said created second-type derivative of said update item with the received first-type derivative of said update item comprises the step of decrypting said first-type derivative.

29. The method of claim 18 wherein the step of checking all timekeeping devices to determine if each is capable of participating in a secure time distribution system comprises the sub-step of distributing encryption key information to each timekeeping device that is determined capable of participating in a secure time distribution system.

30. A computer readable media encoded with program instructions for causing one or more of said timekeeping devices to perform the method of claim 18.

31. A Fibre Channel network having securely distributing time updates, said network comprising:

a primary timekeeping switch;

one or more other time keeping switches;

a first microprocessor at said primary timekeeping switch for (i) causing a check of all timekeeping devices to determine if each is capable of participating in a secure time distribution system, (ii) ascertaining the time and constructing a time update item; (iii) causing the creation of a first-type derivative of said time update item, (iv) causing the creation of a time update message comprising said time update item and said first-type derivative of said time update item;

a first port for sending the time update message to all timekeeping devices;

at a second timekeeping device,

a second port for receiving said time update message,

a first memory for storing said a time of arrival of said update message,

a counter for measuring the age of the received time update at a time interval Tmeasure;

a second memory for storing the time from said time update message;

a second microprocessor for causing (1) the creation of a second-type derivative of said update item; and (2) the comparison of said created second-type derivative of said update item with the received first-type derivative of said update item.

32. The invention of claim 31 wherein said second microprocessor is also for causing frame delay check.

33. The invention of claim 32 wherein causing a frame delay check comprises,

determining a difference between said time of arrival and said time from said time update message; and

comparing said difference with an information transfer delay threshold, said threshold representing the maximum tolerable latency for the transport of the time update message from the primary timekeeping entity to said first timekeeping device.

34. The invention 31 wherein said first memory and said second memory are the same.

35. The invention of claim 31 wherein said Fibre Channel network may not include any device not capable of participating in said secure time distribution.

36. The invention of claim 31 wherein said first-type derivative and said second-type derivative comprise the same derivation process.

37. A Fibre Channel switch for securely maintaining distributed time in a network having a plurality of timekeeping devices and a primary timekeeping entity, said Fibre Channel switch comprising:

a first port for receiving a time update message comprising (i) a time update item comprising the time, and (ii) a first-type derivative of said time update item;

a first memory for storing said a time of arrival of said update message,

a counter for measuring the age of the received time update at a time interval Tmeasure;

a second memory for storing the time from said time update message;

a microprocessor for causing (1) the creation of a second-type derivative of said update item; and (2) the comparison of said created second-type derivative of said update item with the received first-type derivative of said update item.

38. The invention of claim 37 wherein said microprocessor is also for causing frame delay check.

39. The invention of claim 38 wherein causing a frame delay check comprises:

determining a difference between said time of arrival and said time from said time update message; and

comparing said difference with an information transfer delay threshold, said threshold representing the maximum tolerable latency for the transport of the time update message from the primary timekeeping entity to said first timekeeping device.

40. The invention of claim 37 wherein said first memory and said second memory are the same.

41. The invention of claim 37 wherein said first-type derivative and said second-type derivative comprise the same derivation process.